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Art. XV.—*Note of the Occurrence of Fossiliferous Devonian Tuffs in the Dandenong Ranges.*

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Introduction.

In December, 1939, while on a visit to Mt. Dandenong, I noted with interest the occurrence of fine-grained bedded tuffs, closely resembling certain of the tuffaceous Upper Devonian fish beds at Taggerty, inter-stratified with the dacites on the western flanks of the mountain. Although at the time no fossils were obtained, the probability that these tuffs would prove fossiliferous appeared to be strong, and on a subsequent occasion the excellent sections on the new road from Montrose to Kalorama were examined. Tuffaceous beds were then discovered at two localities, one of which yielded fragmentary carbonized plant remains. These fossils, although unfortunately indeterminate, are of considerable significance in that they indicate with certainty the stratification planes in the beds in which they occur, thus permitting the measurement of dip and strike. The presence of the tuffs also enables the upper and lower surfaces of the adjacent lava flows to be determined, giving precise limits to certain of the flows, which previously it had not been possible to fix.

In view of the significance of the occurrence of the tuffs, a rapid reconnaissance of the western flanks of the main Dandenong Range was made, and further discoveries were made at the localities indicated on the map (fig. 1). Plant remains of a type similar to those on the Kalorama road were obtained from two more places, one on the old road from Montrose to Kalorama, and the other at the Glenfern Quarry at Ferntree Gully. The tuffs were thus shown to constitute an important horizon among the lavas, extending over a distance of seven miles along their strike. They therefore afford an important clue to the structure of the Dandenong Range, the significance of which will be discussed below. No attempt, however, has been made at a detailed survey of the district, as a comprehensive study of this and neighbouring areas is being undertaken by another investigator.

The Structure of Mt. Dandenong.

As has been shown by Morris Morris (1914), the Dandenong Ranges and the adjacent country on the north and west are composed chiefly of lava flows, ranging from toscanites at the base of the succession to hypersthene dacite at the top. The lavas are believed to be Upper Devonian in age, for reasons which

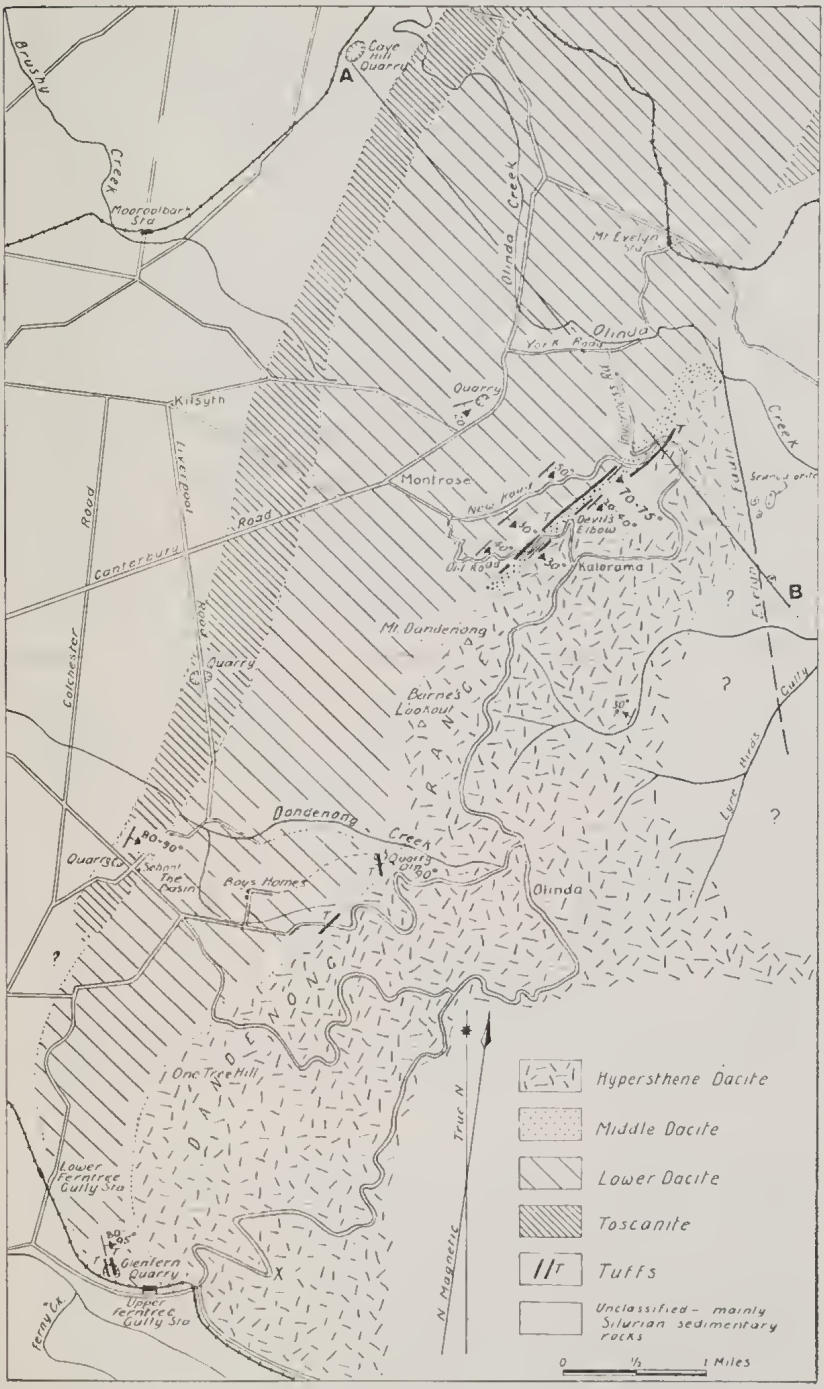

FIG. 1.—Sketch Geological Map of the Dandenong Ranges. Boundaries mainly after Morris Morris (1914), generalized to reveal trend-lines.

have been fully set out in previous publications (Hills, 1931, 1935). Although the newly discovered plant remains have no strict bearing on the age of the lavas, owing to their indeterminate nature, nevertheless they bear a certain superficial resemblance to the plant remains discovered by Hauser in the south Blue Range at Mansfield, these being associated with Upper Devonian fishes (Cookson, 1937; Hills, 1936).

The fossiliferous tuffs on the new road from Montrose to Kalorama are immediately overlain by fresh dacite which exhibits well-marked flow structure. The flow planes, and also the major joints in this dacite are parallel with the stratification planes in the fossiliferous tuffs, and, therefore, must both have been originally horizontal. In the dacite under the tuffs (see detailed sketch map, fig. 2) flow planes are well-marked in places, though elsewhere they are not discernible with certainty. They again indicate the bedding in the lava, but in this rock the major joints have no readily recognizable relationship with the flow planes, usually cutting across them at various angles. It is clear from the sections along this road, however, that for purposes of mapping, the flow planes afford reliable guides to the bedding in the lavas, and that their dip and strike are structurally significant.

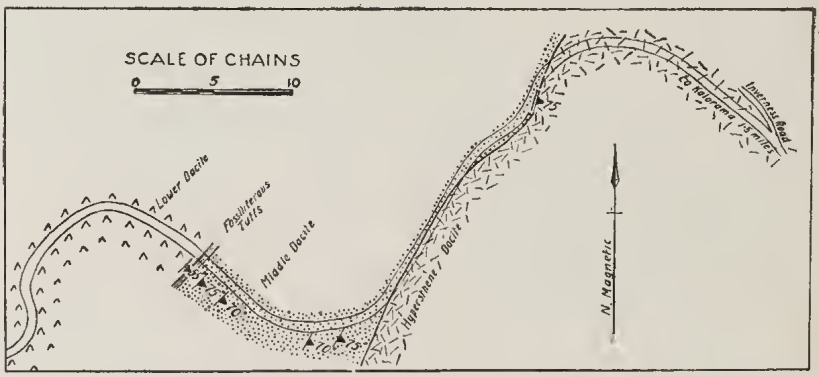

Fig. 2.—Sketch map showing the position of the fossiliferous tuffs on the new road from Montrose to Kalorama, in relation to the adjacent lavas. Dips and strikes of bedding and flow planes are indicated.

Morris Morris was the first to subdivide the lavas of the district into distinct petrological types, but on Mt. Dandenong itself he was unable to indicate any actual boundaries exposed in natural sections. He showed the lavas as essentially horizontal sheets in his cross sections, and there has been no subsequent suggestion that this interpretation might not be correct. It was somewhat surprising to find, therefore, that in the exposures on the new road the tuffs and lavas are dipping at high angles of from 30 degrees to 75 degrees in a south-easterly direction (see figs. 1 and 2). High dips prevail at and above the fossiliferous

tuffs, but on the lower slopes of the mountain there is a gradual decrease to 30 degrees. In two small quarries about 200 yards above Long View House on the new road a characteristic bed of agglomerate, interstratified with the dacites, dips at 30 degrees in conformity with the flow planes in the lavas, thus justifying the use that has been made of the flow planes in mapping.

Owing to Morris' inability to indicate precise boundaries for the middle dacite, there has been in the past some difficulty in the identification of this flow. The upper (hypersthene) dacite is usually readily distinguishable from the lower lavas, chiefly by its characteristic fine texture, and its base can be accurately located on the new road. At its junction with the underlying flow, which is somewhat undulating but dips on the average at 78 degrees to 80 degrees, there occur fine-grained tuffs which are peculiar in that they not only mantle the surface of the lower flow but also extend into it, isolating lenticular masses from the massive rock beneath, and penetrating along cracks. It is suggested that at the time the tuffs were laid down, the surface of the flow on which they were deposited was cracked and covered with boulders. The tuffs entered the cracks, surrounded the boulders, and then, when the hypersthene dacite was extruded and also during subsequent earth movements, shearing occurred in the soft tuffs, the boulders being rolled along and incorporated in them.

The base of this underlying flow immediately overlies the fossiliferous tuffs lower down the road, there being no visible break within the lava between these limits. This flow, then, should correspond with Morris' middle dacite. His mapping agrees with this interpretation, and the petrological characters of the flow correspond closely with his description of the middle dacite. Commencing at the base with a markedly banded type containing coarse and fine layers, the rocks passes up into a facies characterized by numerous large plagioclase phenocrysts with subordinate quartz and biotite, while at the top the phenocrysts are rather smaller, quartz increasing in amount. The nature of the groundmass, shimmering with small flakes of pale-brown biotite, was also commented on by Morris. There can be no doubt, therefore, that this flow, between the precise limits indicated, constitutes the middle dacite as defined by him.

Conforming with this interpretation, the petrological characters of the lavas immediately below the fossiliferous tuffs agree with Morris' description of the lower dacite. This series contains garnet in fair amount, and possesses a granular quartzo-felspathic groundmass with phenocrysts of quartz, plagioclase, and biotite. It is notably fragmental in places, the occurrence of bedded agglomerate at the small quarries referred to above indicating that it consists of more than one flow. The base of this series was accurately located by Morris at several points, and its top is now shown to be at the fossiliferous tuffs on the new road.

On the basis of the reconnaissance survey that has been made, a provisional sketch section showing the structure between Mt. Dandenong and Lilydale may be drawn (fig. 3). While the areal mapping of Morris and observations of flow planes in the lavas indicate the structure of the country to the west of the base of the hypersthene dacite with some degree of accuracy, the interpretation of the eastern part of the section is not easy. Reliable measurements on flow planes in the hypersthene dacite are difficult to obtain, but there is a suggestion in the field, which is to some extent borne out by physiographic evidence, that the dips decrease rapidly towards the east, as they certainly do to the north of York Road. Morris' mapping (1914, Pl. XXX.), shows clearly that in the Lilydale and Mt. Evelyn districts, the general structure of the lavas is that of a broadly open syncline, flanked by the toscanites on the west, north and east. South from Evelyn, however, the eastern boundary is shown by him as the Evelyn Fault, and as will be clear from fig. 1, there can be little doubt that the country to the west of this fault has been downthrown, the steeply-dipping lavas on the northern flanks of Mt. Dandenong being truncated along the line of the fault. The southerly extension of the Evelyn Fault, and of the synclinal structure referred to in the north, is however quite uncertain at present.

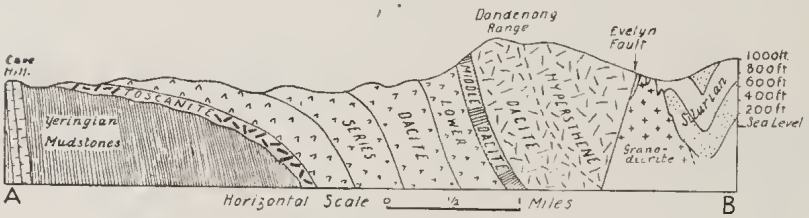

Fig. 3.—Geological section along the line A-B on Fig. 1.

The thickness of the various flows in this district is, as may be seen by comparing fig. 3 with Morris' cross sections, much greater than was formerly thought. The middle dacite is approximately 700 feet thick on Mt. Dandenong, and the lower dacite series of the order of 4,000 feet, the precise values not being determinable without further detailed mapping of boundaries and flow planes.

Structure of the Southern Area.

In traversing south from the new Montrose-Kalorama road, the dips are at first found to decrease somewhat from the high angles of 70 degrees to 75 degrees observed further north, and angles of from 30 degrees to 40 degrees are common. In the disused quarry on the road to "Doongala" near the head of Dandenong Creek, however, pyritized tuffs occur dipping at approximately 90 degrees, although about three-quarters of a mile further

south, on the road from the Basin to Olinda, the dip is apparently much lower, reliable readings on bedding planes not being obtainable. In the Glenfern Quarry at Upper Ferntree Gully, excellent exposures are available, and the occurrence of fossils again removes all doubt as to the attitude of the bedding planes. The fossiliferous tuffs strike at N. 20 W., and dip at 80 degrees in a westerly direction. In all other parts of the quarry, however, flow planes and bedding planes dip at 70 degrees to 80 degrees in an easterly direction, so that it would appear that the plant beds are locally overturned. On the eastern side of the quarry, fine-grained bedded tuffs form massive beds that have been indurated and pyritized, pyritization of the tuffs being also noted at the two localities near Dandenong Creek, above referred to. There are at least two distinct horizons of tuffs in the quarry, and it is, therefore, obvious that several lava flows are present. There is a wide range in the texture of the flows, from dense blue-black types with scattered phenocrysts of quartz, plagioclase, and garnet, to coarsely crystalline saccharoidal varieties. All, however, show a close resemblance to the lower dacite series at the northern end of the range, and the occurrence of interbedded tuffs at the Glenfern Quarry substantiates the conclusion above arrived at that the "lower dacite" is a composite series consisting of interbedded lavas, tuffs, and agglomerates.

In the southern area, the toscanites at the base of the lava succession, as well as the overlying dacites, are steeply dipping. This may be seen in the small quarry near the Basin, where the toscanite is nearly vertical. High dips are thus an essential feature of the main Dandenong Range in a zone extending from Ferntree Gully to Mt. Dandenong, and this discovery affords an adequate structural explanation of the very steep slopes that are characteristic of the western flank of the Dandenong Range. The range is indeed an asymmetrical hogback, with a number of high points such as Mt. Dandenong, Barnes' Lookout, and One Tree Hill, all in hypersthene dacite, on its summit. On the east, however, the hypersthene dacites form a maturely dissected plateau only slightly lower in general elevation than the summit of the main range. This suggests, as above indicated, that the dips may flatten in this direction. Reliable measurements on flow planes could not, however, be obtained in the hypersthene dacite in this district.

Conclusion.

The present investigation has implications concerning several controversial questions of local geology. Firstly, the hypothetical Dandenong Fault, postulated with reservation by Jutson (1911) as bounding the Croydon Lowlands on the east is, as has been previously argued (Hills, 1934), a purely erosional feature. Actually, as was previously concluded on purely physiographic grounds (Hills, 1934, p. 160; 1940, p. 253), the lavas of the Dandenong Range owe their preservation to having been

originally depressed within the crust by folding, possibly aided by ancient faulting, and their present topographic elevation is due to their resistance to erosion. In this regard, the views expressed by Morris Morris (1914, p. 359) were essentially correct, although he regarded the depression of the lavas as being due to their downfaulting between a hypothetical Montrose Fault on the west and the Evelyn Fault on the east. Morris postulated the Montrose Fault because of the rectilinear nature of the junction between the toscanites and the lower dacites. This junction, it will now be clear, is rectilinear because of the high dips in the lavas, and there is no necessity to postulate the existence of a fault in the position shown by him. The structure, insofar as it can be interpreted at present, is rather that of a great monoclinal fold, the axis of which runs obliquely across the lavas of the ranges, in a S.W.–N.E. direction. This axis, in the north, is itself truncated by the Evelyn Fault, trending from east of south to west of north. Along and adjacent to this fault, minor intrusions of granitoid rocks have made their way. In the Ferntree Gully district, however, where the western edge of the lava succession dips at approximately 90 degrees, it may well be that the monocline has passed laterally into a fault, which now separates the Silurian rocks on the west from the Upper Devonian lavas on the east.

In conclusion it may be remarked that the final elucidation of the structure of the Dandenong Ranges, which must await further detailed research, may be expected to have a notable bearing on the Siluro-Devonian tectonics of Victoria, since a Lower or perhaps even Middle Devonian age has recently been indicated for the Lilydale limestone by Dr. Dorothy Hill (1939).

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